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Rate of Growth by Dairy Calves and Heifers on Different Rations

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INTRODUCTION

One of the important problems in dairy farming is to provide rations that are efficient and economical in promoting proper growth and development of dairy calves and heifers. The Bureau of Dairy Industry is conducting a number of feeding experiments at its various field stations to develop useful information on the subject.

Some of these feeding experiments are designed to show the rate of growth by dairy calves and heifers on different types of rations, and they have now reached the stage where the results are available for study and analysis. This circular is a progress report of the investigations under way at the Huntley, Mont., Lewisburg, Tenn., Woodward, Okla., and Jeanerette, La., field stations.[2]

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[1] Kopland is in charge of the dairy work at the Huntley, Mont., field station. At the time this work was done, Simms and Van Horn were superintendents of the Lewisburg, Tenn., and Woodward, Okla., field stations, respectively, and Cathcart was in charge of the dairy work at the Jeanerette, La., station. Van Horn is now superintendent at Lewisburg and Cathcart is in charge of the dairy work at the Columbia, S. C., station. Simms resigned in March, 1940.

[2] The work at these stations is in cooperation with the respective State agricultural experiment stations.

Data compiled by Ragsdale[3] at the Missouri Agricultural Experiment Station on growth standards for dairy cattle are used for comparative purposes in analyzing the results of the experiments reported in this circular. The Missouri data are extensive, are based on weights and measurements taken in the Missouri, Kansas, and Iowa Agricultural Experiment Station herds, and represent systems of feeding and management favorable to good growth. Some of the heifers[4] received whole milk until they were 4 or 5 weeks of age, when they were gradually changed to skim milk, which was continued to the age of 6 to 8 months. Thereafter a grain mixture, alfalfa hay, and corn silage were fed, and a small amount of soaked dried-beet pulp was also fed to a few animals. The weights of Holstein-Friesians and Jerseys that were fed according to this system of feeding will be referred to as the "Missouri standard" for these breeds.

EFFECTS OF EXTENDED SKIM-MILK FEEDING ON THE GROWTH OF DAIRY CALVES AND HEIFERS, AND ON THEIR SUBSEQUENT PRODUCTION

The practice commonly followed in raising dairy calves and heifers on farms where skim milk is available is to start the calves on whole milk and gradually shift them to skim milk and a grain supplement with some roughage, so they will be getting all skim milk by the time they are approximately 30 days of age. Skim-milk feeding is usually discontinued when the calves are 6 months old, or shortly thereafter and the heifers are then raised on grain, roughage, and pasture.

On many dairy farms there is an abundance of skim milk, and unless enough hogs and poultry are kept to consume it a considerable amount is wasted. This waste would be averted if it were found desirable to feed skim milk to older calves and heifers.

Various investigators have accumulated some information relative to the growth of calves fed skim milk beyond 6 months of age, but the data are incomplete, concern very few animals, and do not show the effect of skim-milk feeding on later development and subsequent production.

Since 1926 the Bureau has had an experiment under way at the Huntley, Mont., station in which Holstein-Friesian calves and heifers are fed skim milk until they are 6, 12, 18, or 24 months old, in order to determine the effect of skim-milk feeding on growth, development, and subsequent production. Monthly growth data are now available for study on a total of 91 Holstein females from birth to 2 years of age; on 71 of them from birth to 3 years of age; on 47 to 4 years of age; and on 32 to 5 years of age. Sixty of these animals have completed a first-lactation period and their production records are available for study.

The 91 animals included in this study were sired by 10 different bulls; 85 of the 91 were sired by 6 different bulls.

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[3] RAGSDALE, A. C. GROWTH STANDARDS FOR DAIRY CATTLE. Mo. Agr. Expt. Sta. Bul. 336, 12 pp., illus. 1934.

[4] ——— FEED CONSUMPTION OF DAIRY CATTLE DURING GROWTH. Mo. Agr. Expt. Sta. Bul. 338, 11 pp., illus. 1934.

Plan of the Experiment and Method of Feeding

The experiment was outlined to include skim milk in the ration of the calves born in the Huntley herd, from the time of their birth to various ages, as follows: Calves in group 1 received skim milk to the age of 6 months, group 2 to the age of 12 months, group 3 to the age of 18 months, and group 4 to the age of 24 months.

The calves are numbered consecutively in the order of their birth. To start this experiment 4 consecutively numbered calves were assigned to group 1 at the time of birth; the next 4 consecutively numbered calves were assigned to group 2; the next 4 to group 3; and the next 4 to group 4, and so on. The system of selection was repeated as more calves were born. By 1938 there were 91 animals in the experiment that had reached the age of 2 years or more. Of these, 24 were in group 1, 22 in group 2, 22 in group 3, and 23 in group 4.

The calves in all groups were raised in essentially the same manner, except for the length of time skim milk was included in the ration. They received whole milk for the first 30 days after birth and were then gradually shifted to skim milk. The calves in each group continued to receive skim milk until they reached the age at which the skim-milk-feeding period of the group was completed. The grain mixture (which usually consisted of equal parts of ground oats, barley, mill feed, and linseed meal) was limited to 3 pounds per day, but the calves were allowed free access to alfalfa hay.

When the calves were 9 months of age, the grain was removed from the ration and corn silage (10 to 15 pounds per day) was included. Thus, after the calves were 9 months old they received no feeds other than hay, silage, skim milk, and pasture until they were 2 years of age. Pasture was available only part of the time, and then in such limited amounts that it was not an important factor in the ration. At times silage was not available and alfalfa hay was the only roughage fed. Skim milk was limited to 16 pounds per day at all times.

Some of the animals refused to take skim milk up to the age limit for the group. In such cases skim-milk powder was substituted in amounts equal in dry-matter content to the skim milk during the early part of the experiment. This practice was soon discontinued, however, and when an animal refused to take the skim milk to the age limit of the group, she was dropped from the experiment. The records show that 5 animals refused skim milk at 7 months of age, 9 at 8 months of age, 16 at 9 months, and 8 at 10 months. Two animals in group 4 refused skim milk after they were 23 months of age, but the data on these animals are included.

At the age of 2 years, the heifers were fed grain and roughage to get them in condition for calving. After calving the animals were placed on official test, milked three times a day, and fed a grain ration at the approximate rate of 1 pound of grain to each 3 pounds of milk produced. Alfalfa hay and corn silage were allowed at will; and during the pasture season the animals received a limited amount of grazing on irrigated pasture.

METHOD OF KEEPING RECORDS

All animals were weighed at birth and thereafter on 3 consecutive days at the beginning of each calendar month. The average of the 3 daily weights is used as the weight for the month. Monthly weights and gains are recorded from birth to 2 years of age, and yearly weights and gains are recorded from 2 to 5 years of age. The recorded weights at 36, 48, and 60 months of age represent the average of the last 12 monthly weights in each instance. Routine breeding and feeding records were kept. Since individual-consumption records on roughage and grain were not kept, they are recorded as the average of the group. For example, if 30 pounds of alfalfa hay was fed daily to a group of five calves, each calf was credited with a consumption of 6 pounds.

The usual policy was to breed the heifers at the first heat period after they were 15 months old, so they would calve when 2 years 1 month of age. The average age of calving, however, was 30 months, with some variation between groups, as some heifers did not conceive on the first service.

EFFECT ON BODY WEIGHTS AND GAINS

The growth of the heifers in all groups is shown in figure 1 by monthly weights from birth to 24 months of age and thereafter by yearly weights.

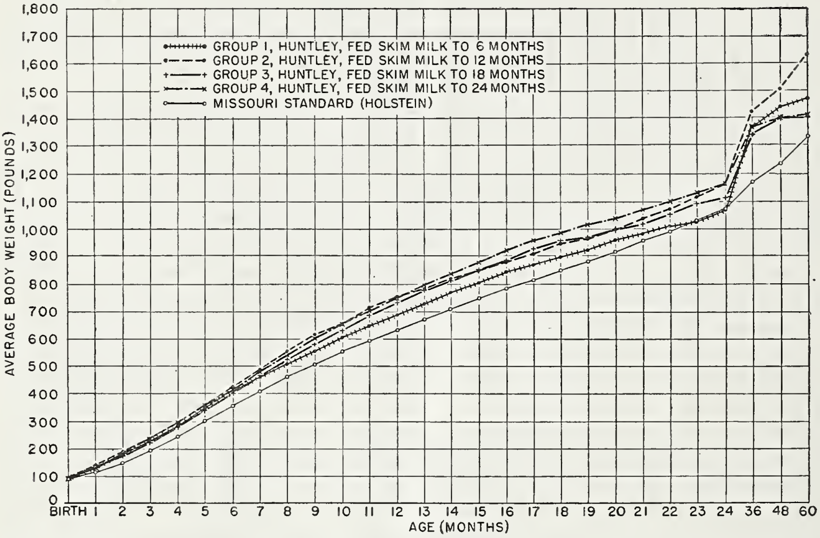

FIGURE 1.—Average weights by months of Holstein heifers when fed skim milk to various ages at Huntley, Mont., and according to the Missouri standard.

Table 1 shows the average monthly gains by 3-month periods for the 4 Huntley groups, from birth to 24 months of age, and by years from 3 to 5 years of age. For example, at the age of 6 months the heifers of group 1 averaged 406 pounds in body weight, and the average gain per month during the 3-month period of the fourth, fifth, and sixth months was 60.3. The weights of Holstein heifers, as indicated by the so-called Missouri standard,[5] are also given for the same ages.

The birth weights for the four Huntley groups were very similar, and were about the same as the Missouri standard. Up to 6 months

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[5] See footnote 3, p. 2.

TABLE 1.—*Average monthly gains, by three-month periods, of Holstein heifers that were fed skim milk to 6, 12, 18, and 24 months of age at the Huntley station, compared with the Missouri standard*

Age [1] (Months)	Group 1			Group 2			Group 3			Group 4			Missouri standard		
	Animals	Average weight	Average monthly gain	Animals	Average weight	Average monthly gain	Animals	Average weight	Average monthly gain	Animals	Average weight	Average monthly gain	Animals	Average weight	Average monthly gain
	No.	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*
At birth	24	90	-----	22	91	-----	22	93	-----	23	93	-----	239	90	-----
3	24	225	45.0	22	238	49.0	22	222	43.0	23	233	46.7	234	193	34.3
6	24	406	60.3	22	422	61.3	22	401	59.7	23	416	61.0	231	355	54.0
9	24	557	50.3	22	614	64.0	22	581	60.0	23	600	61.3	217	509	51.3
12	24	686	43.0	22	749	45.0	22	730	49.7	23	746	48.7	200	632	41.0
15	24	799	37.7	22	847	32.7	22	850	40.0	23	877	43.7	185	746	38.0
18	24	895	32.0	22	946	33.0	22	956	35.3	23	982	35.0	165	845	33.0
21	24	978	27.7	22	1,030	28.0	22	1,016	20.0	23	1,067	28.3	150	952	35.7
24	24	1,061	27.7	22	1,154	41.3	22	1,108	30.7	23	1,159	30.7	140	1,069	39.0
36	19	[2]1,364	-----	16	[2]1,422	-----	18	[2]1,339	-----	18	[2]1,364	-----	75	1,165	-----
48	15	[2]1,440	-----	8	[2]1,505	-----	11	[2]1,394	-----	13	[2]1,398	-----	48	1,232	-----
60	8	[2]1,470	-----	6	[2]1,630	-----	8	[2]1,399	-----	10	[2]1,409	-----	41	1,330	-----

[1] Age when skim-milk feeding was discontinued: Group 1, 6 months; group 2, 12 months; group 3, 18 months; group 4, 24 months.

[2] Average of the last 12 monthly weights.

of age the four groups had the same ration, and the variation in weights at this age was only slightly greater than the variation at birth. The lowest weight, however, was 401 pounds for group 3, which was 13 percent greater than the Missouri standard.

The average monthly gain during the fourth, fifth, and sixth months of age, as shown in table 1, was as follows: By group 1, 60.3; group 2, 61.3; group 3, 59.7; and group 4, 61.0 pounds; and by the Missouri standard, 54. All the Huntley heifers were gaining very uniformly during this period. During the seventh, eighth, and ninth months the rate of gain of group 1 was slowed up about 10 pounds, apparently because skim milk was removed from the ration, but the three other groups, continuing on skim milk, gained at about the same rate as during the preceding 3 months.

The rate of gain, as is well known, tends to decline as animals grow older. The rate of gain, with continued skim-milk feeding, was well maintained by groups 2, 3, and 4 up to the end of the ninth month, but thereafter declined rapidly. Whether the decline was due only to advancing age or in part to removal of the grain from the ration after 9 months is not known; the Missouri standard shows a similar decline, but it is possible that the animals on which this standard is based had received grain after they were 9 months of age.

During the tenth, eleventh, and twelfth months the rate of gain for group 2 dropped nearly to that for group 1. Groups 3 and 4 gained at a faster rate than group 2, possibly because they had not gained as rapidly as group 2 in the preceding 3 months. During the thirteenth, fourteenth, and fifteenth months group 2 made the lowest rate of gain, the skim milk being removed from its ration at the end of the twelfth month. During the sixteenth, seventeenth, and eighteenth months the rate of gain continued to decline but very slowly in all groups except group 2, which made the same average monthly gain as in the preceding 3 months. That of the two groups still receiving skim milk was only 2 or 3 pounds more per month than for the other two groups. In the nineteenth, twentieth, and twenty-first months the rate of gain continued downward in all groups; the rate being practically the same for groups 1, 2, and 4, at approximately 28 pounds, but only 20 for group 3, which had been taken off skim milk at the beginning of this period. The Missouri standard, however, showed a slight increase.

During the twenty-second, twenty-third, and twenty-fourth months the average monthly gain increased in all groups except group 1, in which it was the same as for the previous 3-month period. Pregnancy might possibly account for some of the differences in rate of gain though apparently not far enough advanced in any group to have any material effect. At 24 months of age group 1 averaged 66, group 2, 126, group 3, 145, group 4, 118 days in pregnancy. In the case of group 2 (with 126 days of pregnancy) there was an increase in the rate of gain of only about 12 pounds as compared with the preceding 3-month period. In groups 1, 3, and 4 there was little change in the rate.

At 24 months of age group 2, fed skim milk to 12 months, differed little in average weight from group 4, fed skim milk to 24 months. Group 1, fed skim milk to 6 months, averaged about 95 pounds less than group 2 or group 4, while group 3, fed skim milk to 18 months, weighed more than group 1 but less than group 2 or 4.

To summarize the effects on growth up to 24 months of age, it may be pointed out that in groups 1, 2, and 3 there was a decided decline in the rate of gain for a few months after the skim milk was removed from the ration. Since young animals gain weight more rapidly than older animals, the group that was deprived of skim milk at the youngest age was the one that suffered the greatest retardation in growth. In order to develop well-grown 2-year-olds it appears advisable, from the results obtained in this experiment, to feed skim milk to the age of 9 months and, if the skim milk is readily available, to feed it to the age of 12 months. From the standpoint of growth alone, however, these results do not indicate that anything is to be gained by feeding skim milk beyond the age of 12 months.

This is further shown by the average weights for 36, 48, and 60 months of age (table 1). While the heifers in group 1 weighed less on the average than those in the other groups at 24 months of age, they equaled the weight of the heifers in groups 3 and 4 in the third year and averaged heavier in the fourth and fifth years. For some unknown reason the heifers in group 2 averaged considerably heavier than those in the other groups for the third year, and continued to average much heavier during the fourth and fifth years of age. The average weights of heifers in groups 1 and 2 at 2 years of age were 72.2 and 70.8 percent, respectively, of their average weights for the fifth year, while the average weights of those in groups 3 and 4 at 2 years of age were 79.2 and 82.3 percent, respectively, of their average weights for the fifth year. This indicates that the animals in the first two groups made a larger portion of their final weight after they were 24 months of age than did those in the last two groups. In view of the fact that the heifers in group 2 were heavier than the others at 24 months, and that those in group 1 had caught up with those in group 4 and were heavier than those in group 3 in the third year of age, this continued greater rapidity of gain at advanced ages by the groups deprived of skim milk first is surprising.

INFLUENCE OF PREGNANCY ON THE GAINS IN WEIGHT

In order to throw more light on the influence of pregnancy on the results obtained in this experiment, the individual animals were classified according to the number of days they were pregnant prior to 24 months of age. Their average weights at 18 and 24 months of age and the gain for this 6-month period are given in table 2. The number of individuals is too small in most cases to show the effect of pregnancy on the rate of gain, but the combined data for all groups do show rather definitely that 150 days or less of pregnancy had little if any effect on the average gain in weight. As the period of pregnancy advanced beyond 150 days there was a decided increase in gains as shown by an average gain of 187 pounds for all animals that had carried calves from 151 to 210 days, and an average gain of 228 pounds for all animals that had carried calves for 211 days or longer. The average weight at the age of 24 months increased with each advanced stage of pregnancy.

TABLE 2.—*Effect of pregnancy on gain in weight by Holstein heifers, from 18 to 24 months of age* [1]

Length of pregnancy period prior to 24 months of age (days)	Group 1				Group 2				Group 3				Group 4				All groups			
	Animals	Average weight at—		Average gain	Animals	Average weight at—		Average gain	Animals	Average weight at—		Average gain								
		18 months	24 months			18 months	24 months			18 months	24 months									
	No.	*Lb.*	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*	*Lb.*								
Not pregnant	5	873	1, 021	148	4	934	1, 129	195	2	995	1, 098	103	3	934	1, 077	143	14	921	1, 075	154
1 to 90	12	885	1, 048	163	5	992	1, 184	192	7	983	1, 112	129	7	961	1, 094	133	31	942	1, 095	153
91 to 150	3	964	1, 145	181	2	1, 063	1, 216	153	2	892	1, 003	111	5	976	1, 125	149	12	974	1, 125	151
151 to 210	4	900	1, 088	188	4	887	1, 071	184	2	992	1, 153	161	1	1, 093	1, 331	238	11	929	1, 116	187
211 or more					7	922	1, 177	255	9	932	1, 120	188	6	1, 014	1, 270	256	22	951	1, 179	228

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[1] Age at which skim-milk feeding was discontinued: group 1, 6; group 2, 12; group 3, 18; and group 4, 24 months.

COMPARATIVE BREEDING EFFICIENCY OF THE GROUPS IN THE SKIM-MILK FEEDING EXPERIMENT

The average number of services required for a conception, together with other breeding data on the heifers in the four Huntley groups, are shown in table 3.

For the first conception group 1 had the lowest average breeding efficiency and group 2 the next lowest, while there was very little difference between groups 3 and 4. A total of 199 services were required for the 45 first-calf conceptions by groups 1 and 2, which is a

TABLE 3.—*Average services for a conception, days pregnant at 24 months of age, and birth weight of first calves, for groups of Holstein heifers fed skim milk to 6, 12, 18, and 24 months of age, at Huntley, Mont.*

Group	First conception		Stage of pregnancy at 24 months of age		Age at first calving		Birth weight of first calves		Second conception	
	Animals	Average services required	Animals	Days of pregnancy	Animals	Age	Animals	Weight	Animals	Average services required
	Number	*Number*	*Number*	*Number*	*Number*	*Months*	*Number*	*Pounds*	*Number*	*Number*
1	23	5.0	23	66	22	31	20	88	16	2.0
2	22	3.8	22	126	22	29	20	93	15	2.9
3	22	3.1	22	145	19	30	18	90	15	2.7
4	23	3.0	22	118	22	30	21	93	17	2.2

breeding efficiency of 23 percent; and 135 services were required for the 45 conceptions by groups 3 and 4, which is a breeding efficiency of 33 percent. This difference cannot be attributed to a difference in fertility of the bulls, because the same bulls were used in all groups. Since the environmental conditions and the nutritional factors other than the length of time that skim milk was fed were uniform for all groups, it appears that the longer skim-milk feeding periods for groups 3 and 4 may account for their higher breeding efficiency. Possibly the skim milk, when fed for long periods, provided constituents that enabled the heifers in these groups to be more resistant to the conditions or infections that cause difficulty in conception, particularly in first conceptions.

Table 3 also shows the number of services required per conception by heifers in this experiment when bred for their second calves. In this case the heifers were on full-feed rations (p. 3) and were on official test, under uniform conditions of milking and management. Groups 1 and 2 required a total of 75 services for 31 conceptions, which is a breeding efficiency of 41.3 percent; and groups 3 and 4 required 79 services for 32 conceptions, which is a breeding efficiency of 40.5 percent. This was a marked improvement in breeding efficiency for all groups and especially for groups 1 and 2. The fact that the breeding efficiency for second calving was so equalized for the 4 groups would appear to corroborate the theory that the skim milk furnished some specific nutrient that was lacking in the hay and silage fed to groups 1 and 2 after 12 months of age, but not lacking in the full-feed ration fed to all groups after the first calving, were it not for the fact that more services are usually required for first-calf conceptions than for subsequent conceptions.

The feeding of skim milk apparently had no effect on the birth weights of the first calves dropped by the heifers in the 4 groups.

MILK AND BUTTERFAT PRODUCTION OF HEIFERS FED SKIM MILK TO VARIOUS AGES

Table 4 shows the average milk and butterfat production for the 60 heifers that made comparable (365-day) records in their first-calf lactation periods, while on official test. The ages at first calving were fairly well balanced.

TABLE 4.—*Average milk and butterfat production of the heifers that had completed a yearly record in the skim-milk feeding experiment,*[1] *arranged according to their sires*

Sire of heifers that made records	Group 1			Group 2			Group 3			Group 4		
		Production			Production			Production			Production	
	Animals	Milk	Butterfat	Animals	Milk	Butterfat	Animals	Milk	Butterfat	Animals	Milk	Butterfat
	No.	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*	*No.*	*Lb.*	*Lb.*	*No.*	*Lb.*	*No.*
Pride of the Bess Burkes	----	----	----	2	10, 363	420	5	14, 508	541	2	12, 956	478
Friend Ona Hartog Korndyke	4	12, 686	423	----	----	----	----	----	----	4	14, 966	524
U Neb Klaver King	3	14, 613	522	5	15, 608	553	5	14, 290	488	4	14, 169	514
Sir Colantha Old Inn Hero	3	11, 254	393	3	11, 696	415	4	12, 270	438	3	11, 660	449
Miscellaneous sires	7	11, 440	443	3	11, 541	454	----	----	----	3	14, 088	505
Total or average	17	12, 260	443	13	12, 960	478	14	13, 790	493	16	13, 731	498

[1] Group 1 was fed skim milk to 6 months of age, group 2 to 12, group 3 to 18, and group 4 to 24.

The average milk production, which was lowest for group 1, increased with each group in the order of the length of the skim-milk feeding period except for the group that was fed skim milk to 24 months of age. Average butterfat production, however, increased for all four groups with each increase in length of the skim-milk feeding period. Furthermore, groups 3 and 4 carried calves for a longer period than groups 1 and 2. The increased yield that appears to go with a longer skim-milk feeding period cannot be attributed entirely to the increased size of the heifers at the time of first calving, since the heifers in group 2 averaged approximately the same in weight as group 4 at 24 months of age but did not produce as much milk and butterfat. The heifers in group 2 were also larger than those of group 3 at 24 months of age, but did not produce as much milk and butterfat.

Although the four groups were handled and fed in a similar manner except for the length of the skim-milk feeding period, it was recognized that differences in the inheritance for producing ability would affect the yields by the different groups. In an effort to determine to what extent differences in inheritance may have been responsible for the differences in production, an analysis was made of the lines of breeding of these four groups of heifers.

The breeding experiments at Huntley require the use of meritoriously proved sires in the herd at all times. The number of direct proved-sire crosses was determined for each of the 60 heifers in the four groups, and the number was averaged by groups. It is assumed that heifers having the greatest number of proved-sire crosses are the least likely to have an inheritance for a low level of production. The heifers in group 1 had an average of 2.9 direct proved-sire crosses; group 2 an average of 2.5; group 3 an average of 3.2; and group 4 an average of 2.7. On this basis, the inheritance of the four groups would seem to be fairly well balanced, with group 3 having a slight advantage.

Two of the proved sires used in the Huntley herd (U Neb Klaver King and Sir Colantha Old Inn Hero) had daughters in each of the four groups (table 4). The average production of the daughters of U Neb Klaver King in the different groups shows no direct relation to the length of the skim-milk feeding period, the average for groups 1 and 2 being higher than the averages for groups 3 and 4. On the other hand, the average production of the daughters of Sir Colantha Old Inn Hero increases with each group in the same order as the length of the skim-milk feeding period. The other sires do not have daughters in all four groups, but in general their daughters in groups 1 and 2 are lower producers than their daughters in groups 3 and 4. The average yields of the 60 daughters of all the sires correspond, in magnitude by groups, with the increase in the length of the skim-milk feeding period, although the differences between groups 2, 3, and 4 are not great.

The evidence appears to indicate there was a difference in the producing ability of these heifers that corresponded to some extent with the length of the skim-milk feeding period and that this difference apparently was not due to differences in inheritance. The difference between the average production of the heifers that received skim milk to 12 months and those that received skim milk to 18 and 24 months of age was not sufficiently great to justify the feeding of skim milk beyond the age of 12 months. Whether these differences in producing ability will continue during subsequent lactations is not known. Davis and Willett[6] at the Nebraska station attempted to correlate rapidity of growth as indicated by gain in weight, by increase in height at withers, and by increase in chest girth from birth to 2 years of age, with milk and butterfat production for the first lactation and the average production for all lactations. Seventy-six Holstein females in the University of Nebraska dairy herd were used. No apparent correlation was observable.

Practical Considerations

A review of the skim-milk feeding experiment warrants the following conclusions:

Apparently calves that can be induced to take skim milk until they are 10 or 12 months of age will continue to do so for an indefinite period.

From the standpoint of growth as measured by body weight, there is no advantage to be gained by feeding skim milk to Holstein heifers beyond the age of 12 months.

In this experiment a pregnancy period of less than 150 days had little if any effect on the average gain in weight before the age of 2 years. As the pregnancy period advanced beyond 150 days there was an increase in gains proportionate to the increased period of pregnancy.

There is some evidence that the longer periods of skim-milk feeding resulted in a somewhat higher breeding efficiency. It is possible that skim milk, when fed for long periods, provides constituents that enable the heifers to resist adverse conditions or infections that cause difficulty in first conceptions.

The length of time skim milk was fed had no apparent effect on the birth weights of the first calves dropped.

The data indicate there was a difference in the producing ability of the heifers that corresponded to some extent with the length of the skim-milk feeding period and that this difference apparently was not due to differences in inheritance. The difference was not sufficiently great, however, to warrant the feeding of skim milk beyond the age of 12 months.

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[6] Davis, H. P., and Willett, E. L. RELATION BETWEEN RATE OF GROWTH AND MILK AND FAT PRODUCTION. Jour. Dairy Sci. 21: 637–642. 1938.

WINTERING HEIFERS ON SUMAC SORGO SILAGE AND LIMITED AMOUNTS OF COTTONSEED MEAL

A heifer-feeding experiment was carried out at the Woodward, Okla., station of this Bureau for the purpose of determining the rate of gain and the relative economy of the gains made by yearling Holstein-Friesian heifers, when they were fed sumac sorgo silage as the sole roughage, with the addition of a high-protein concentrate fed at two different levels; and when they were fed good legume hay with the sumac sorgo silage, and some grain.

Sumac sorgo is drought resistant, has proved to be a very desirable crop for silage, and is increasing in importance as a roughage for dairy cattle in regions where it is one of the leading crops. Cost-of-production figures for 1936 and 1937 at the Woodward station show that the silage was produced at $2.50 per ton in the silo or around $0.89 per 100 pounds of total digestible nutrients. Cottonseed meal, the high-protein concentrate fed in this experiment, is usually a cheap source of protein and of total digestible nutrients. Cheap and efficient winter rations for heifers that will result in adequate growth are essential to profitable dairying in this and other localities.

Plan of the Experiment

The feeding experiment was first conducted 100 days in the winter of 1936–37 and was repeated in the winter of 1937–38, when it was run 121 days. Three groups of three heifers each were fed each winter as follows: Group 1 was fed sumac sorgo silage at will and cottonseed meal was limited to 1 pound per day; group 2 was fed sumac sorgo silage at will and cottonseed meal was limited to 2 pounds per day; group 3 had sumac sorgo silage at will; alfalfa hay, limited to 6 pounds per day; and a grain mixture, limited to 2 pounds per day. Salt and bonemeal were available to all groups.

Table 5 shows the average age and weight of the heifers used in each trial, at the time they started on the respective rations; also the other essential data on the 1937 and 1938 feeding trials, together with the averages for the two trials. It was not possible to balance the groups in age and weight because of few available animals. The heifers used in 1937 ranged in age from 13 to 25 months at the beginning of the trial, and it was thought desirable to group them according to age and size. Therefore, the younger and smaller animals were placed in group 3 (to get silage, hay, and grain). They averaged 13 months of age and 815 pounds in body weight, when the experiment started. The heifers in group 1 (to get silage and 1 pound of cottonseed meal) averaged 18 months of age, and 1,000 pounds in weight at the time the experiment was started. One heifer aborted while on the experiment and the data for this animal was excluded. The heifers in group 2 (to be allowed 2 pounds of cottonseed meal with their silage) averaged 22 months of age and 1,130 pounds in body weight. In 1938 the same plan was followed in arranging the groups, but the heifers were better balanced in age and weight. One heifer in group 3 freshened during the course of the 1938 feeding trial and the data for this animal are excluded.

TABLE 5.—*Average age, body weight, and gain in weight during two feeding trials with three rations fed groups of Holstein heifers, at Woodward, Okla.*

Ration fed, group, and year	Period of feeding	Animals in trial	Average age when feeding trial began	Average time calf was carried	Initial body weight	Final body weight	Total gain for period	Average daily gain	Body weight in relation to Missouri standard[1]	
									At beginning of feeding trial	At end of feeding trial
Silage (made of sumac sorgo) and 1 pound of cottonseed meal:										
Group 1:	*Days*	*Number*	*Months*	*Days*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Percent*
1937	100	2	18	20	1,000	1,150	150	1.50	118	120
1938	121	3	19	55	946	1,157	211	1.70	108	113
Average	111		18.5	38	973	1,154	181	1.60	[2] 112	[2] 116
Silage and 2 pounds of meal:										
Group 2:										
1937	100	3	22	65	1,130	1,323	193	1.80	115	120
1938	121	3	18	38	985	1,204	219	1.80	117	122
Average	111		20	51	1,058	1,264	206	1.80	[2] 116	[2] 121
Silage, hay, and 2 pounds of grain:										
Group 3:										
1937	100	3	13	0	815	958	143	1.40	121	122
1938	121	2	16	12	862	1,046	184	1.50	110	115
Average	111		14.5	6	839	1,002	163	1.45	[2] 117	[2] 119

[1] See text, p. 2.

[2] Weighted average.

All the heifers had been raised in the same manner up to the time they were started on the experimental ration. They had been accustomed to eating large amounts of roughage, and had been fed skim milk to an older age than is customary. The heifers in groups 1 and 3 had received skim milk to an average age of 14 months and those in group 2 to 16 months. In the light of the data presented in the first section of this circular (pp. 4–6) it is not likely that the extended skim-milk feeding had any significant effect on the relative gains of the three groups in this experiment. That they were well developed at the time they started on the feeding trial is shown by the fact that their weights at that time averaged 12 to 17 percent above the Missouri standard (table 5).

The average length of time the heifers were in calf during the trials ranged from 6 days for group 3 to 51 days for group 2. The average time for all groups (15 days) was so short that it probably was not a significant factor in the gains made during the feeding trials.

GAINS IN BODY WEIGHT

The total and average gains in body weight made by the heifers on the three rations during the two feeding trials are shown in table 5.

The heifers in group 3 (fed a ration of silage, alfalfa hay, and 2 pounds of mixed grain per day) gained slightly less per day than the heifers in groups 1 and 2. This is rather surprising because the heifers in group 3 were the youngest, and therefore should have made somewhat more rapid gains, and because they also received a more varied ration. It is significant, however, that the average daily gains for groups 1 and 3 were greater in 1938 than in 1937. This is referred to later in the discussion of feed and nutrient consumption (p. 14).

The average weight of the heifers in group 1 at the beginning of the feeding trials (average of 2 years' results) was 12 percent above the Missouri standard, and at the end of the feeding trials it was 16 percent above. The average weight of the heifers in group 2 increased at approximately the same ratio as group 1, while the average for group 3 increased from 17 percent above the Missouri standard to 19 percent above.

FEED AND NUTRIENT CONSUMPTION

Table 6 shows the total feed consumption per heifer by the different groups and the average amount consumed daily. It also shows the average daily consumption of dry matter in the ration.

TABLE 6.—*Average feed and dry-matter consumption per heifer when different rations were fed three groups of Holstein heifers in two winter feeding trials at Woodward, Okla.*

Group, year, and period	Roughage fed				Concentrate fed				Dry matter consumed per heifer per day
	Sumac sorgo silage		Alfalfa hay		Cottonseed meal		Grain mixture		
	Total amount	Per heifer per day	Total amount	Per heifer per day	Total amount	Per heifer per day	Total amount	Per heifer per day	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Group 1:									
1937 (100 days)	14,890	74			200	1			18.8
1938 (121 days)	20,880	58			363	1			15.0
Average	17,885	[1] 64			282	1			[1] 16.4
Group 2:									
1937 (100 days)	26,040	87			600	2			22.9
1938 (121 days)	22,389	62			726	2			16.9
Average	24,213	[1] 73			663	2			[1] 19.5
Group 3:									
1937 (100 days)	15,290	51	1,570	5			600	2	18.7
1938 (121 days)	9,099	38	1,452	6			484	2	16.4
Average	12,195	[1] 45	1,511	[1] 6			542	2	[1] 17.2

[1] Weighted average.

No analyses were made of any of the feeds, except of the silage for dry-matter content. This averaged 24.2 percent for the 2 years. All other calculations are based on average analyses taken from Morrison.[7]

Because of the extremely dry summers the sumac sorgo crops did not produce mature seed either year; however, the silage fed in the 1938 trial was made from a more mature crop than that fed in 1937 and contained a considerable amount of seed that was in the milk and dough stage when the crop was ensiled. The silage fed in the 1937 trial contained practically no seed.

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[7] MORRISON, F. B. FEEDS AND FEEDING, A HANDBOOK FOR THE STUDENT STOCKMAN. Ed. 20, unabridged, 1050 pp., illus. Ithaca, N. Y. 1936.

The animals in all three groups consumed more silage per day in 1937 than in 1938. Because of the greater daily consumption of silage, the daily consumption of dry matter and the total digestible nutrients were also higher in 1937 for all groups. It will be recalled, however, that group 1 made a greater daily gain in weight in 1938 than in 1937 and that group 2 made the same daily gain both years (table 5), in spite of the fact that both groups consumed less silage in 1938. Since each group received cottonseed meal at the same rate in both years, these results indicate that the silage fed in 1938 (which was from the more mature crop) was considerably more efficient than that fed in 1937.

Another interesting point is the fact that during both years the heifers in group 2 (fed 2 pounds of cottonseed meal per day) consumed more silage per day than the heifers in group 1 (fed only 1 pound of cottonseed meal a day). This is in accordance with other experiments carried on by the Bureau [8] in which cows that were fed a limited amount of grain consumed approximately as much corn silage and alfalfa hay as when they were fed the alfalfa hay and silage without grain.

The 2-year average results indicate that the two rations fed to groups 1 and 2 (silage at will and 1 pound or 2 pounds of cottonseed meal per day) were superior to the ration fed to group 3 (2 pounds of grain, alfalfa hay, and silage). The heifers in group 3, however, were from 4 to 5 months younger than those in groups 1 and 2, and possibly would not have been able to consume sufficient silage if it had formed their only roughage. As it was, they obtained 63 percent of their dry matter in the form of silage and 25 percent in the form of alfalfa hay; whereas group 1 heifers obtained 95 percent and group 2 heifers 91 percent of their dry matter from silage.

Comparative Costs of Rations

Table 7 shows the amount of feed consumed per heifer during the two feeding trials, the total cost of feed per heifer, and the feed costs per 100 pounds of gain in body weight, for the three groups fed different rations.

Table 7.—*Amounts of feed consumed per animal, and the feed costs per animal and per 100 pounds of gain in body weight, for three groups of Holstein heifers fed different rations at Woodward, Okla.*

Group	Quantity of feed consumed				Cost of feed				Total cost of feed	Cost of feed per 100 pounds of gain
	Sumac sorgo silage	Alfalfa hay	Cottonseed meal	Grain mixture	Sumac sorgo silage	Alfalfa hay	Cottonseed meal	Grain mixture		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	7,104		111		8.88		1.83		10.71	5.92
2	8,103		222		10.13		3.66		13.79	6.69
3	4,495	666		222	6.24	6.66		2.77	15.67	9.61

The sumac sorgo silage was valued at $2.50 a ton, which was the actual cost of producing the silage (2-year average) excluding land rent, interest, and taxes. Inclusion of these costs would increase the cost of the silage materially, since the yields per acre were low, averaging 3.5 tons. These costs will vary widely with land values, taxes, etc. The reader can apply this additional cost in accordance with prevailing rates in his region. If the cost per ton of silage were increased to $4 a ton, by the addition of these other cost items, the feed cost per 100 pounds of gain would be $8.86, $9.64, and $11.91 for groups 1, 2, and 3, respectively. Cottonseed meal was valued at $33 per ton, alfalfa hay at $20 per ton, and the grain mixture at $25 per ton. These values represent approximately the average prices that prevailed at the Woodward station during the 2-year period.

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[8] MOSELLY, T. W., STUART, DUNCAN, and GRAVES, R. R. DAIRY WORK AT THE HUNTLEY FIELD STATION, HUNTLEY, MONT., 1918–1927. U. S. Dept. Agr. Tech. Bul. 116, 48 pp., illus. 1929.

The results show that sumac sorgo silage fed as the sole roughage, plus 1 or 2 pounds of cottonseed meal per head daily, constituted an efficient and economical winter ration for the Holstein heifers under the conditions in this experiment.

Since good growth of the heifers was obtained with all three rations, the relative economy of feeding sumac sorgo silage with limited amounts of cottonseed meal, as compared to alfalfa hay and some grain, depends very largely on the variations in the relative costs of the two roughages. For example, in times when alfalfa hay could be purchased cheaply it might pay the farmer with sumac sorgo silage to purchase and feed hay during all or part of the winter and keep his silage for feeding later on in the spring when hay is scarcer and relatively high-priced.

GAINS OF JERSEY CALVES AND HEIFERS ON MACHINE-DRIED LEGUME HAY AND PASTURE

When the Lewisburg, Tenn., station of the Bureau of Dairy Industry was established in 1930, experiments were started on several phases of a general program directed toward a study of the feeding value of roughages for dairy cattle and the problems involved in the production of higher quality roughages. A rotary-type drier was installed, and a large proportion of the roughage crops produced on the farm each year has been artificially dried and used in feeding experiments or fed to the general dairy herd. Data are gradually accumulating to indicate the feeding value of such roughages.

Artificial drying of roughage does not add to its nutritive value, but the artificially cured roughage contains a larger percentage of its original nutrients than the average field-cured roughage. Roughage cured in the field may lose a considerable percentage of the nutrients it contained at the time of cutting, depending on weather conditions and the efficiency of the methods of curing. Artificially dried roughages are therefore usually superior to field-cured roughages, particularly in humid regions. In view of this superior feeding value, an experiment was started to determine whether Jersey calves and heifers that were fed this type of roughage exclusively, beginning at early ages, would make satisfactory growth and develop normally.

Preliminary Experiment With Young Bull Calves

In a preliminary experiment seven Jersey bull calves were started on artificially dried roughage exclusively at 6 months of age. At this age, when skim-milk and grain feeding was discontinued, these calves were 35 pounds lighter than the average for Jersey bull calves according to the Missouri standard.[9] At 12 months of age, after they had been on this roughage exclusively for 6 months, they were 81 pounds lighter than the Missouri standard. At 18 months of age, when the experiment was ended and they had been on this ration for 12 months, they were 95 pounds lighter than the Missouri standard. During the first 6 months of the experiment, their average gain was 46 pounds less than the average gain indicated by the Missouri standard, and during the second 6 months it was only 14 pounds less.

It is assumed that the bulls representing the Missouri standard for this age-period were fed a mixed ration that included grain and silage. This experiment appears to indicate that the age of 6 months was too early to start the calves on the ration of roughage alone for them to make gains comparable to those made on mixed rations, including grain.

The Heifer-Feeding Experiment

The experiment with Jersey heifers was started in January 1932. The data reported here cover the 5 years (1932–36) during which time a total of 57 heifers were maintained on an experimental summer- and winter-feeding schedule from the time they were 12 months until they were 24 months of age.

Prior to their start on the experimental feeding schedule at 12 months, all heifers had been raised alike. They had been fed whole milk from birth to 15 days of age, after which they received skim milk, grain, and roughage. Skim-milk feeding was discontinued at 6 months of age, but the calves continued to receive grain (limited to 2 pounds daily) and hay and some pasture to 12 months of age, when they were assigned to one of three groups in the experiment.

In assigning a heifer to one of the groups, particular attention was given to keeping the groups balanced for size, thriftiness, and breeding of the animals, and for the season of the year in which animals were started in the experiment.

Throughout the experiment, all heifers were maintained on pasture during the pasture season, without any other feed whatever; and during the winter months they were fed one of the following rations: Group 1 received machine-dried roughage at will; group 2 received machine-dried roughage (limited to 10 pounds daily) with 2 pounds of grain; group 3 received machine-dried roughage (limited to 8 pounds daily) with 3 pounds of grain.

The heifers were on pasture for an average of approximately 249 days a year (the pasture season ranged from a minimum of 228 days in 1933 to a maximum of 268 days in 1932) and they were barn fed on the winter rations for an average of approximately 116 days a year.

The roughage fed during the 5-year period consisted of approximately 85 percent of soybean hay, with alfalfa, cowpea, or grass hay making up the remaining 15 percent. All the roughage was dried in the rotary-type drier, the green material being run through a hay cutter before drying.

Cottonseed meal of 41-percent crude-protein content was the only concentrate fed in the winter of 1932–33, while a home-mixed grain ration containing 16 percent of crude protein was fed the two following winters. Salt was given at weekly intervals, and no other mineral supplements were supplied. During the first two winters all heifers were housed in a pen barn and had the free run of a pen, with the exception that the heifers in groups 2 and 3 were stanchioned while cleaning up their feed. During the last three winters all the heifers were housed in a stanchion barn and kept tied except for a short time twice daily while they were being watered. The animals were weighed monthly. It is believed that all variations in conditions other than feed were of minor importance and did not affect the results of the feeding experiment.

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[9] See footnote 3, p. 2.

BODY WEIGHTS AND GAINS

Table 8 shows the average weights at birth and by 6-month periods up to 24 months of age, and the average 6-month gains by each group, together with similar data from the Missouri standard. Figure 2 is a graphic presentation of the monthly gains made by the groups from birth to 24 months of age.

TABLE 8.—*Weight at birth and by 6-month periods for three groups of Jersey heifers that were fed different experimental rations* [1] *after the twelfth month of age, compared with the Missouri standard*

Age (months)	Group 1 (18 heifers)		Group 2 (19 heifers)		Group 3 (20 heifers)		Missouri standard [2]		
	Average weight	Average gain	Average weight	Average gain	Average weight	Average gain	Heifers	Average weight	Average gain
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Number*	*Pounds*	*Pounds*
At birth	[3] 51	---------	[3] 52	---------	[4] 54	---------	173	53	---------
6 months	237	186	[4] 239	187	[5] 246	192	167	243	190
12 months	411	174	420	181	420	174	159	450	207
18 months	554	143	542	122	553	133	129	601	151
24 months	682	128	669	127	684	131	118	733	132

[1] For rations fed, see text, p. 16.
[2] See text, p. 2.
[3] Average for 16 heifers.
[4] Average for 18 heifers.
[5] Average for 19 heifers.

The heifers in group 1 (receiving pasture alone during the summer and machine-dried roughage at will during the winter) made an average gain of 271 pounds from the twelfth to the twenty-fourth month of age, which was greater than the gains by the other two groups. Group 1 also made more uniform monthly gains than the other groups. Group 3 (receiving pasture alone during the summer months and 8 pounds of machine-dried roughage and 3 pounds of grain per day during the winter) made an average gain of 264 pounds; and group 2 (receiving pasture during the summer and 10 pounds of machine-dried roughage and 2 pounds of grain per day during the winter months) an average of 249 pounds. The average gain by the Missouri standard for the same age period was 283 pounds.

The fact that these heifers were not so heavy at 24 months of age as the Missouri standard was probably because of their low rate of gain between 6 and 12 months of age, prior to the start of this experiment. During that 6-month period, the three groups failed by 33, 26, and 33 pounds, respectively, to gain as much as the Missouri standard. For the next 6-month period ending at 18 months of age, the three groups failed by 8, 29, and 18 pounds, respectively, to gain as much as the Missouri standard. But for the 6-month period ending at 24 months of age, the three groups lacked only 4, 5, and 1 pound, respectively, of equaling the gains made by the Missouri standard.

At 2 years of age, the heifers in group 1 had carried calves an average of 119 days as compared to 108 days for group 2, and 84 days for group 3. The slightly longer period of pregnancy for group 1 probably did not affect the average gain from 18 to 24 months of age. In the feeding experiment with Holstein heifers at Huntley (p. 7), pregnancies of less than 150 days had little effect on the rate of gain.

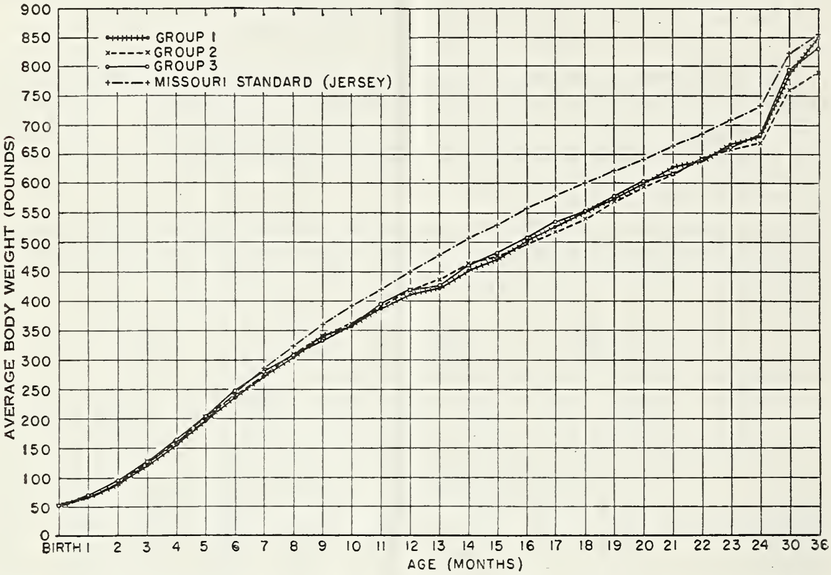

Figure 2.—Average weights and gains at 1 to 24, 30, and 36 months of age, for three groups of Jersey heifers that were fed different rations after the twelfth month, and for average Jerseys according to the Missouri standard.

The comparative gains made by the three groups during the winter-feeding season and during the pasture season are shown in table 9. All groups made their greatest monthly gain in June and their lowest in November, except that group 3 had an average loss of 1 pound during April.

The change from barn feeding to pasture was usually made late in March, and rather abruptly. The change from pasture to barn feeding was usually made in October. There was a marked depression in gains in weight for a period following the change from barn feeding to pasture and for a period following the change from pasture to barn feeding. Since the animals were affected in a similar manner by both changes, the marked loss in gain following the change in ration apparently was due to failure of the animals to consume suffici-

Table 9.—*Average gain in body weight by calendar months, and the average monthly gain during the 4-month winter feeding period and the 8-month pasture season, of three groups of Jersey heifers* [1]

Group	Heifers in group	Average gain												Average monthly gain	
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Winter period (Dec.-Mar.)	Pasture season (Apr.-Nov.)
	No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1	18	20	26	11	11	13	53	30	31	35	23	7	20	19	25
2	19	16	16	19	16	23	52	29	21	31	22	7	18	17	25
3	20	25	27	18	−1	18	47	32	27	30	24	11	13	21	24

[1] All groups received only pasture during the pasture season. For winter rations fed, see text, p. 16.

ent nutrients on the new ration rather than to change in the quality of the ration. Since the heifers were turned on pasture very early in the spring, there is the possibility that the grass did not yet have the substance, or was not plentiful enough, to support normal gains. Group 1, receiving roughage alone during the winter, was somewhat more affected by the change to pasture in the spring than group 2, though group 1 was getting more nutrients from the all-roughage ration than group 2 was getting from roughage and 2 pounds of grain.

From the figures in table 9 it was calculated that the heifers in groups 1 and 2 made 73 and 74 percent, respectively, of their total yearly gain during the pasture season and 27 and 26 percent, respectively, during the winter-feeding period; while the heifers in group 3 made 69 percent of their yearly gain during the pasture season and 31 percent during the winter-feeding period. Since the pasture season constituted approximately 68 percent of the total year, the total gains made on pasture were slightly greater proportionately than those made on the winter rations.

Forty-three animals in the three groups have now reached 3 years or more of age. Eleven animals in group 1 averaged 849 pounds in body weight when 36 months old (average of 12 monthly weights) with an average gain of 167 pounds from the age of 24 months; 16 animals in group 2 averaged 790 pounds at 36 months of age, gaining an average of 121 pounds; and 16 animals in group 3 averaged 831 pounds in body weight at 36 months of age with a gain of 147 pounds.

While this experiment was in progress the pasture and hay crops produced on the station farm were seriously affected each year by droughts. Probably, the nutritive value of the pasture grass and hay was reduced because of the dry weather. For instance, the pastures were exceedingly dry during August 1932, and the heifers made no gain. However, with heavy rains late in July and early in August 1933, the pastures were green and the average gain was 34 pounds per animal during August. In 1931, 1932, and 1934, some of the soybean plants died before early bloom as a result of dry weather. This caused loss of leaves and fine parts and increased the fiber content of the hay. These conditions account to some extent for the fact that the average weight of the heifers was below the Missouri standard.

But perhaps the most important reason for their lower weights was the low rate of gain during the months immediately following changes from barn feeding to pasture, and from pasture to barn feeding.

FEED AND NUTRIENT CONSUMPTION

In the winter-feeding period, the heifers in group 1 consumed an average of 15.8 pounds of machine-dried hay per day; they were fed all they would eat without any other feed. Group 2 received an average of 10 pounds of hay and 2 of grain per day; and group 3 received 8 pounds of hay and 3 of grain per day. By using the average analyses from Morrison,[10] it was calculated that the machine-dried hay averaged approxinately 55 percent in total digestible nutrients, and the grain ration averaged 76.1 percent. Computations on this basis show that the amount of total digestible nutrients consumed during the winter-feeding period averaged 8.72 pounds per heifer per day for group 1, 7.04 for group 2, and 6.7 for group 3. Group 2 consumed only 80 percent as much total digestible nutrients per day as group 1, and group 3 consumed only 77 percent as much. According to the Morrison feeding standards for growing cattle, the heifers in group 1 consumed approximately 26 percent more (total digestible nutrients) than their calculated requirements; group 2 consumed approximately 10 percent more; and group 3 approximately 5 percent more. It would appear that the winter gains made by the three groups of heifers were not consistent with their consumption of total digestible nutrients. Compared to the gains by groups 2 and 3, group 1 should have made greater gains than they did.

SUMMARY OF THE RESULTS

The results of this experiment warrant the conclusion that Jersey heifers from the age of 12 months will make satisfactory growth (as measured by body weight) when given an unlimited quantity of machine-dried legume hay of good quality during the winter and abundant pasture during the summer, under the same conditions as prevailed at Lewisburg, Tenn.

Of the total yearly gain made by the group of 18 Jersey heifers on this ration, approximately 73 percent was made during the pasture season and 27 percent during the winter-feeding period. Since the winter-feeding period constituted approximately 32 percent of the total year, the rate of gain during the pasture and winter-feeding period was very nearly the same, the former being slightly greater.

The results of this experiment also indicate the desirability of making gradual shifts from winter rations to summer pasture, or vice versa, in order to avoid severe setbacks in gains in body weight.

GAINS OF JERSEY CALVES AND HEIFERS ON MACHINE-DRIED LEGUME HAY WITHOUT PASTURE

The Jeanerette, La., station of the Bureau of Dairy Industry is located in the Gulf coast region, which is characterized by heavy rainfall, high humidity, and a long growing season. Under these conditions certain grasses and clovers grow well, but it is difficult, and often impossible, to cure them into desirable hay in the field. To overcome this difficulty experiments with mechanical hay driers were started several years ago at this station by the Bureau of Agricultural Engineering. Since 1932 practically all of the crops grown for hay have been cured in a rotary-type drier.

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[10] See footnote 7, p. 13.

Long-time feeding experiments with Jersey cattle are in progress for the purpose of obtaining information on the feeding value of the machine-dried hay. One phase of these experiments is that of raising the heifers on machine-dried hay alone, without pasture, from the time they are 12 months old until they are 18 months old. This is a report of the progress on that phase of the investigation.

The calves are fed whole milk from birth to 30 days of age, then gradually shifted to skim milk, grain, and hay. Skim-milk feeding is usually discontinued at 7 months of age, but occasionally an unthrifty calf is fed skim milk for a longer time. Six of the 13 heifers in this hay-feeding experiment, however, were included in another experiment in which they received skim milk (16 pounds per day) up to the age of 12 months. No pasture is allowed the calves during their first year, other than the small amount of grazing they may obtain in the calf lots. Grain is limited to 3 pounds per day.

From 12 to 18 months of age, all the heifers are fed a ration of machine-dried legume hay exclusively. During this 6-month period they get all the hay they will eat, but no pasture, silage, or grain. From 18 months of age until they freshen, they are on pasture during the pasture season (otherwise on machine-dried hay) with corn silage and grain in addition. Since 1936, a total of 13 heifers have been on this feeding schedule to 18 months of age, and 11 to 24 months or more of age.

The machine-dried hay fed during this 3-year period (1936–38) was approximately 85 percent of clover (mostly Louisiana white, some red clover, and other mixed clovers and grasses) and about 5 percent each of soybean, alfalfa, and grass hay. It was planned to cut all of this hay at early stages of maturity in order to obtain the highest nutritive value, but this was not always possible, and occasionally a cutting was not of the best quality. In 1937 samples of each cutting of the materials run through the drier were analyzed. Table 10 shows the average crude-protein and crude-fiber content of these samples. The green material was cut rather fine before it was run through the drier.

Table 10.—*Average content of crude protein and crude fiber in the machine-dried hay, 1937 (dry-matter basis)*

Material run through the drier	Crude protein	Crude fiber
	Percent	*Percent*
Red clover (2 cuttings)	17.69	34.84
Clover (Louisiana white) with some grass	15.88	24.88
Clover (miscellaneous mixture)	15.34	24.32
Alfalfa (2 cuttings)	17.77	26.92

In order to compare the growth of these 13 heifers with the growth by other heifers raised under the same environmental conditions monthly weights were tabulated for 46 heifers raised in the main herd prior to 1936. The 46 heifers and the 13 heifers were raised in a similar manner up to 12 months of age (a few of the 46 and 6 of the 13 received skim milk to 12 months of age). From 12 to 18 months of age, however, the 13 heifers had only machine-dried roughage, whereas the 46 had pasture in season or were winter-fed on field-cured legume hay, corn silage, and grain. Table 11 gives the average weights and gains of these two groups by 6-month periods. Further comparisons are made by including the 6-month averages for group 1 (table 8) that was fed on machine-dried hay and pasture at Lewis-

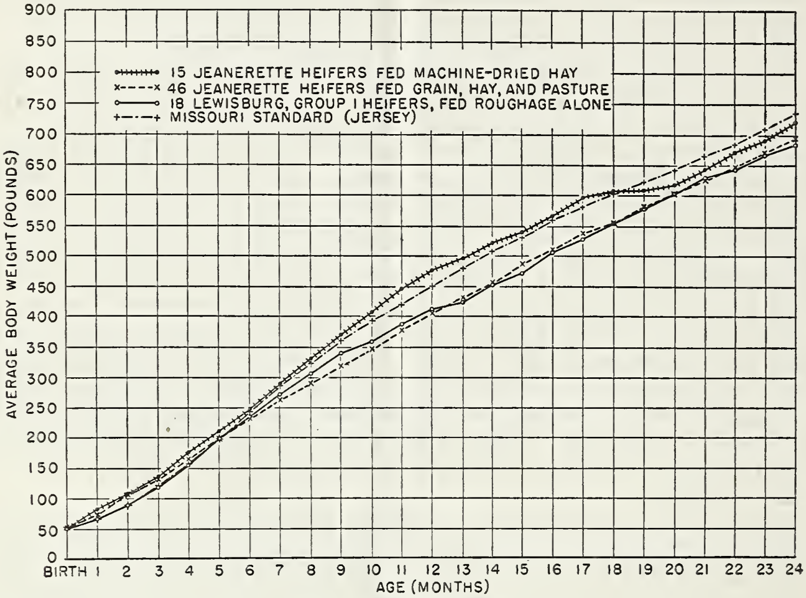

FIGURE 3.—Monthly body weights of Jersey heifers at Jeanerette, La., that were fed solely on hay from 12 to 18 months of age, as compared to the group fed roughage alone at Lewisburg, Tenn., and two groups on more varied rations.

TABLE 11.—*Weights at birth and by 6-month periods of Jersey heifers at Jeanerette, La., that were fed machine-dried legume hay alone from 12 to 18 months of age, with comparative weights of other groups of Jersey heifers* [1]

Age (months)	Group (13 heifers) in experiment at Jeanerette with machine-dried hay		Group (46 heifers) raised at Jeanerette in regular manner		Lewisburg, group 1 (18 heifers)		Missouri standard		
	Average weight	Average gain	Average weight	Average gain	Average weight	Average gain	Animals	Average weight	Average gain
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Number*	*Pounds*	*Pounds*
At birth	51		[2] 51		[3] 51		173	53	
6	248	197	233	182	237	186	167	243	190
12	476	228	406	173	411	174	159	450	207
18	608	132	556	151	554	143	129	601	151
24	[4] 721	113	693	137	682	128	118	733	132

[1] For description of rations fed each group, see text.
[2] Average for 37 heifers.
[3] Average for 16 heifers.
[4] Average for 11 heifers.

burg, Tenn., and those for the Missouri standard.[11] Figure 3 shows the monthly weights of the four groups graphically.

At 12 months of age, when the 13 heifers were placed on the experimental ration of machine-dried roughage alone, their average body weight was 476 pounds, or 70 pounds more than that of the 46 heifers that were raised in the regular manner. The former group had gained an average of 228 pounds from 6 months of age, as compared to 173 pounds for the latter. Probably this was due to the fact that nearly 50 percent of the former group had skim milk to 12 months of age. The 13 heifers were 26 pounds above the Missouri standard in average body weight at 12 months of age, while the 46 heifers were 44 pounds under the Missouri standard.

At 18 months of age the 13 heifers averaged 608 pounds in body weight, a gain of 132 pounds in 6 months, or 0.73 pound per day. The 46 heifers gained an average of 151 pounds in the same age period, or 0.84 pound per day. The Lewisburg heifers, also on a roughage ration during the same age period, gained at the average rate of 0.79 pound per day.

The 13 heifers averaged 6 percent heavier than the Missouri standard at 12 months of age, but only 1 percent heavier at 18 months of age. From 18 to 24 months of age, the 13 heifers made a lower gain than any of the other groups. This may have been due partly to the fact that they were above normal weight at 18 months of age. They had carried calves for an average of only 62 days up to 24 months of age.

The hay consumption of the 13 heifers, during the 6 months on that ration, was 13.9 pounds per heifer per day, averaging 10.6 pounds at 13 months of age and gradually increasing to 15 at 18 months. This was somewhat less than the 15.8 pounds consumed by the group of Jersey heifers in the Lewisburg experiment that were fed on machine-dried roughage alone during the winter-feeding period (p. 20). If the machine-dried roughage fed to both groups is assumed to have the same total digestible nutrient content (55 percent), the Jeanerette heifers consumed 7.65 pounds of total digestible nutrients daily and the Lewisburg heifers 8.72 pounds. The Lewisburg group was lighter in body weight than the Jeanerette group and consumed approximately 26 percent more total digestible nutrients than they required, while the Jeanerette heifers, being heavier, just about met their nutrient requirements.

The results of this experiment agree with the results of the Lewisburg experiment in that Jersey heifers over 1 year of age will make satisfactory gains (as measured by body weight) when given an unlimited quantity of machine-dried legume hay of good quality without the addition of silage or concentrates.

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[11] See footnote 3, p. 2.

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